Crane Technology Development and Advanced Shipboard Crane Motion Control System ATD

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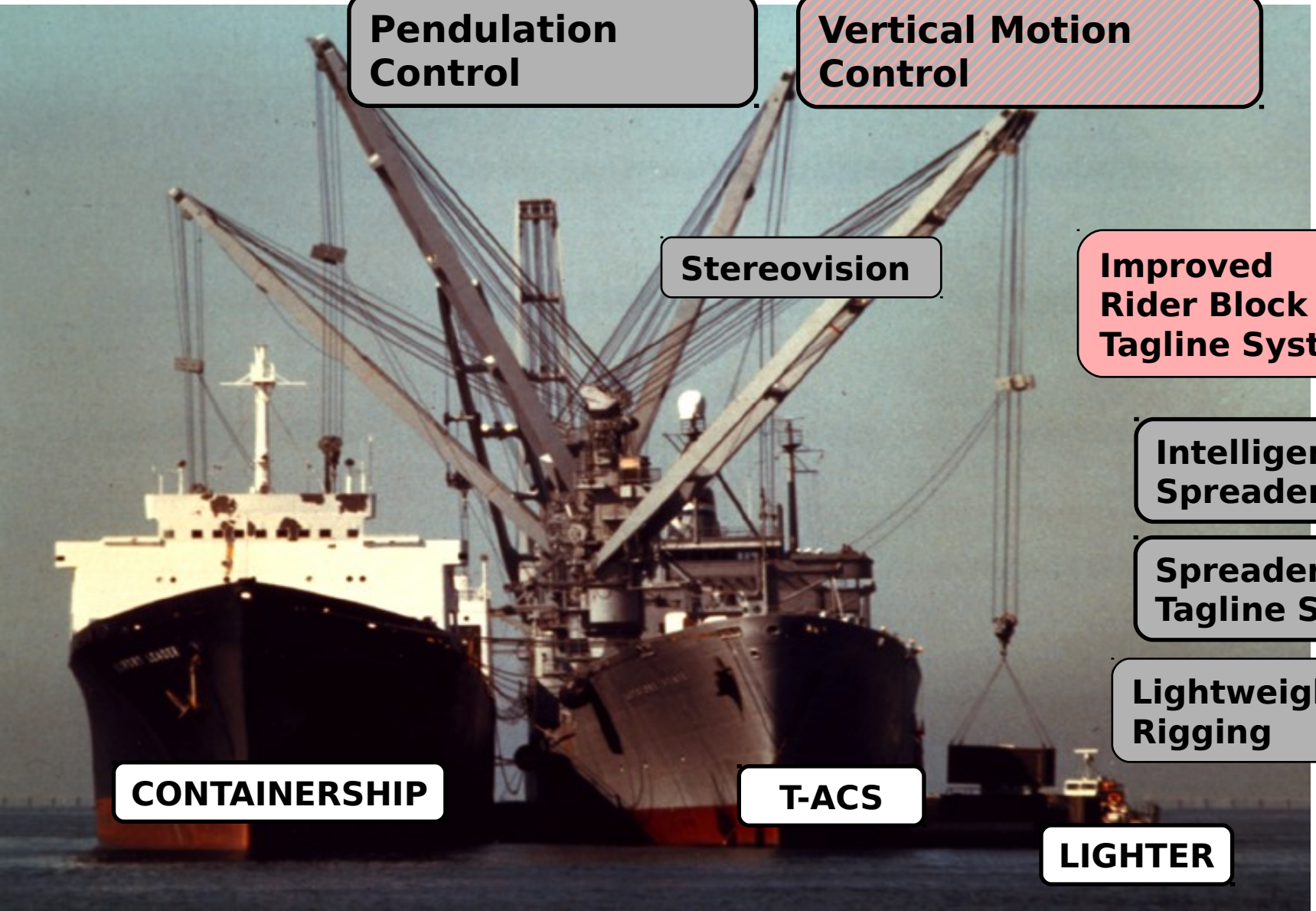
JLOTS R&D Symposium

2 Feb 2000

Shipboard Crane Systems



ADVANCED SHIPBOARD CRANE MOTION CONTROL SYSTEM

Advanced Technology Demonstration

OPNAV Sponsor: N4; N42, Mr. Kaskin; N422, CAPT (Sel) Brannon
Technical Manager: ONR 331, Dr. Abraham
Program Manager: PEO EXW; PMS 385, Mr. Fink
Program Execution Manager: CDNSWC 282, Mr. Rausch

Advanced Shipboard Crane Motion Control System ATD

Problem - Pendulation

Load pendulation is caused by:

- **crane operator**
- **ship motion**
- **system dynamics**

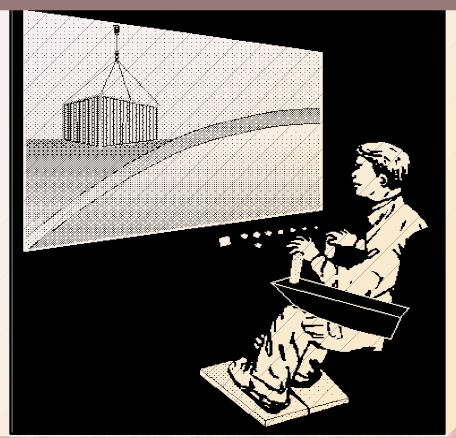
Pendulation slows all crane operations in any sea state and prevents any safe crane operations from high sea state 2

This ATD solves these problems.

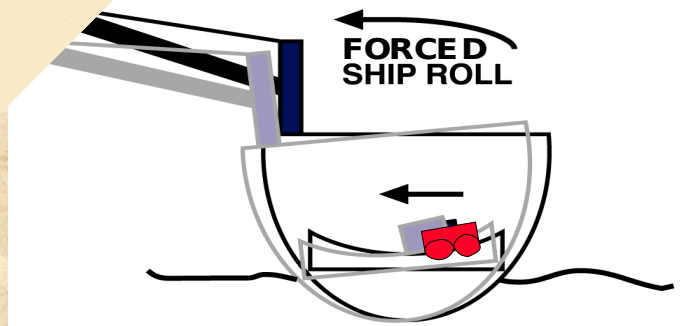
ADVANCED CRANE MOTION CONTROL ATD
TECHNICAL APPROACH

TECHNICAL APPROACH

SIMULATION
Computer Simulator/Trainer



T-ACS ship roll STIMULATION
Demonstration and Training



Anti-Pendulation Non-linear Dynamic Control Algorithm Development

- Video

CRANE SIMULATOR

Increase the existing crane trainer to include the IRBTS and the pendulation control system.

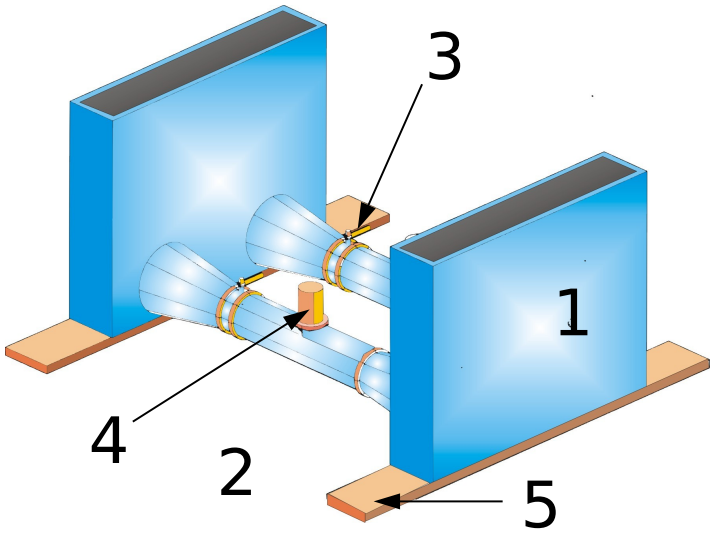
Roll Stimulator
Concepts
1/8th Scale Model
FLUME TANKS
COUNTER ROTATING WEIGHTS

SHIP ROLL STIMULATOR

Major Components of Final Roll Stimulation Concepts

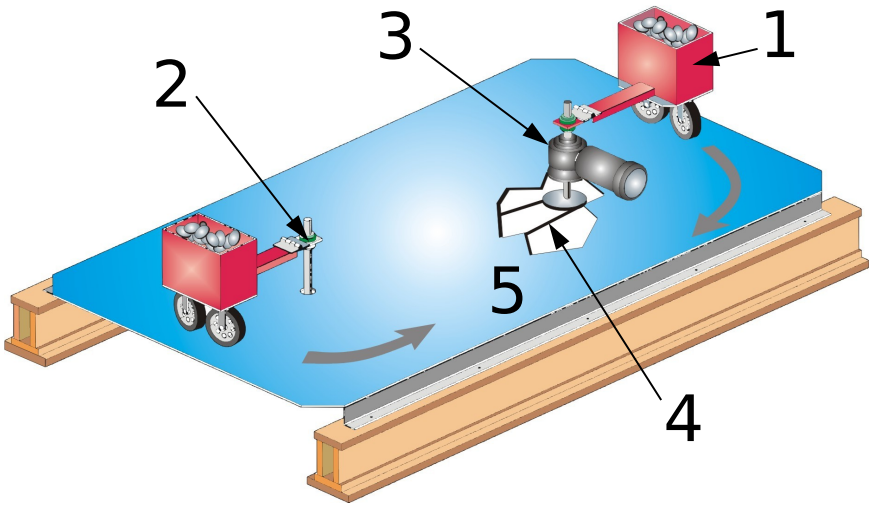
FLUME TANKS

1. Water Tanks
2. Transfer Tubes
3. Butterfly Valves
4. Hydraulic Bow Thruster Units
5. Base Mounting Board

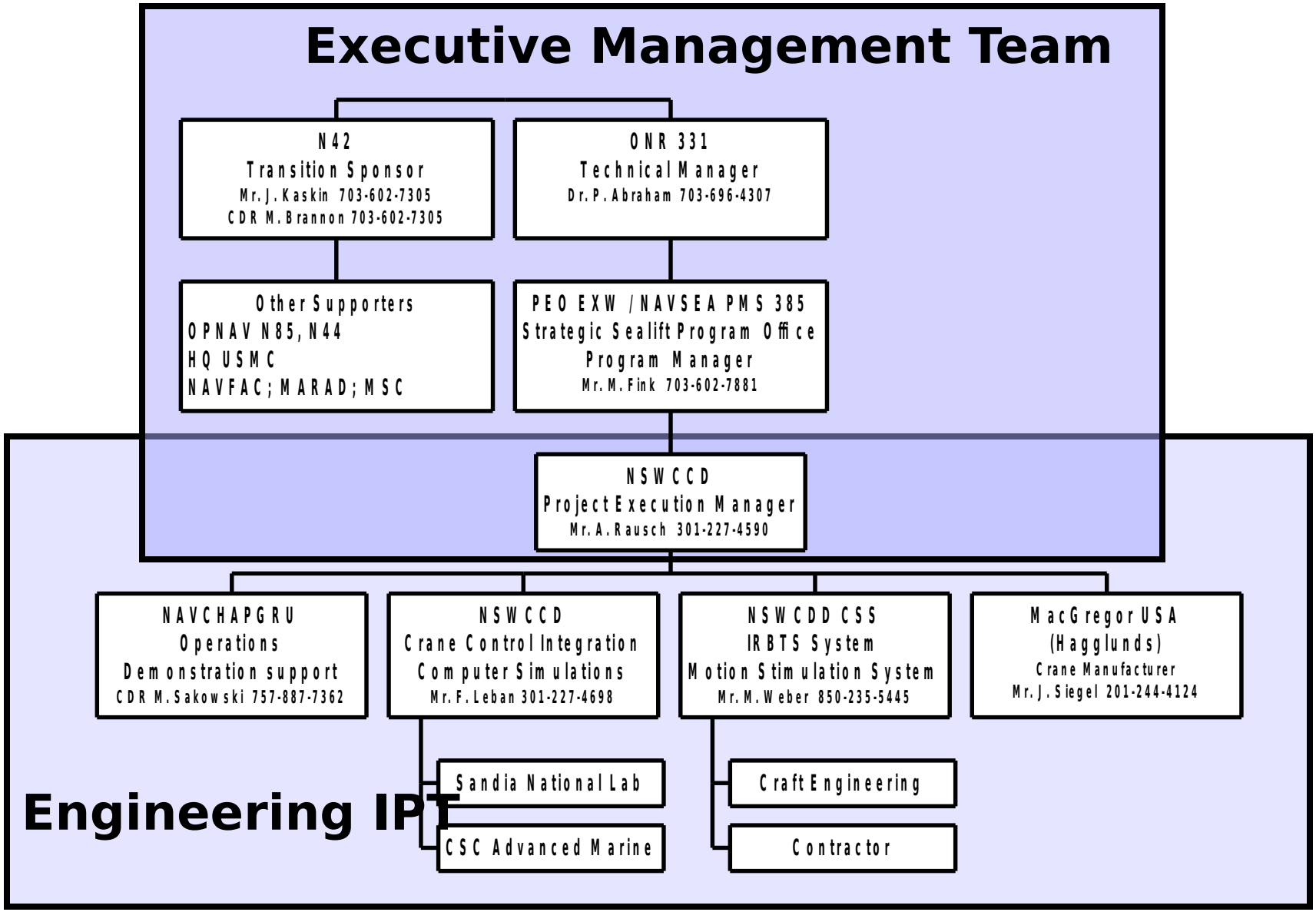


COUNTER ROTATING WEIGHTS

1. Weighted Carts
2. Drive Shafts & Bearings
3. Drive Motor & Reduction Gear
4. Reversing Chain Drive



ATD Management Structure



Advanced Shipboard Crane Motion Control System ATD

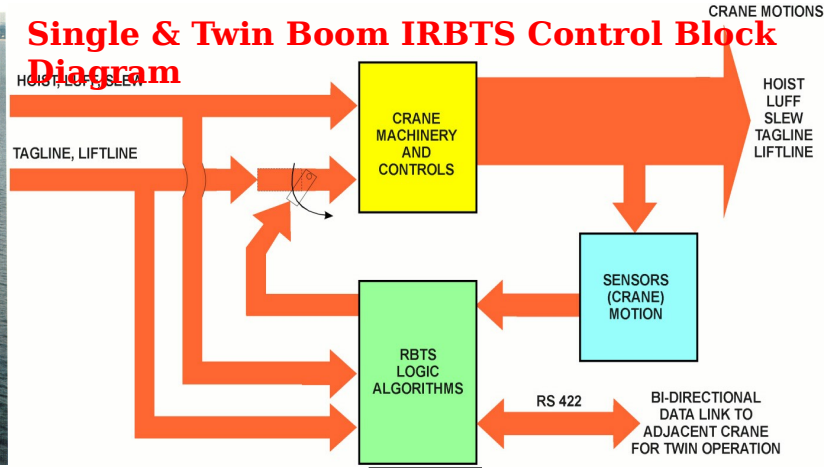
Summary

FY99 6.3 Funding Results:

- Roll Stimulator Concept Evaluation and Selection
- Crane Machinery characterization underway
- Crane Simulator Modifications underway

Naval Sea Systems Command
NSWC
Naval Surface Warfare Center
A TRADITION OF EXCELLENCE
Panama City Dahlgren

INTEGRATED RIDER BLOCK TAGLINE SYSTEM (IRBTS)



Develop an improved RBTS by automating the cont system aboard T-ACS and LMSR ships and eliminat slack rope conditions, increasing safety and operat efficiency.

Naval Sea Systems Command
NSWC
Naval Surface Warfare Center
A TRADITION OF EXCELLENCE
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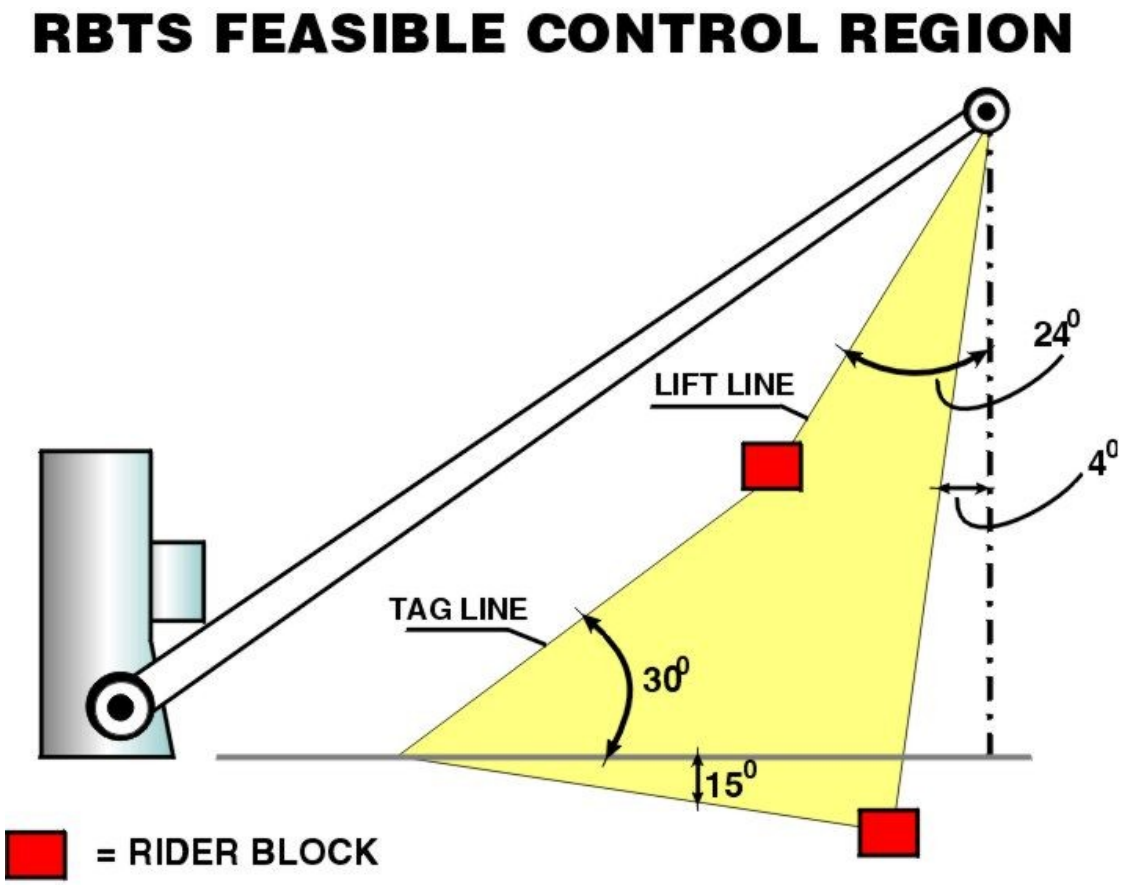
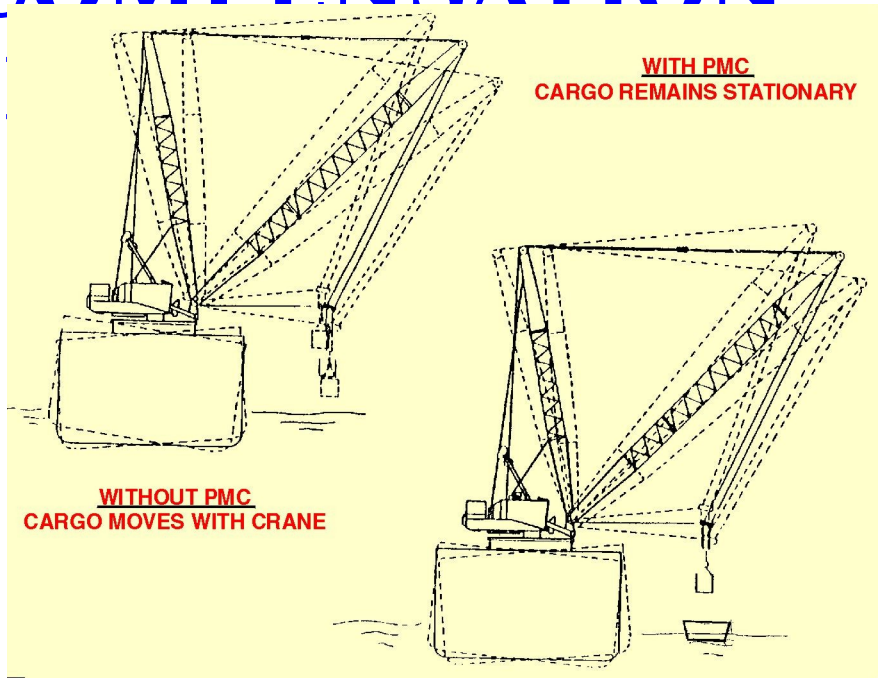
INTEGRATED RIDER BLOC TAGLINE SYSTEM



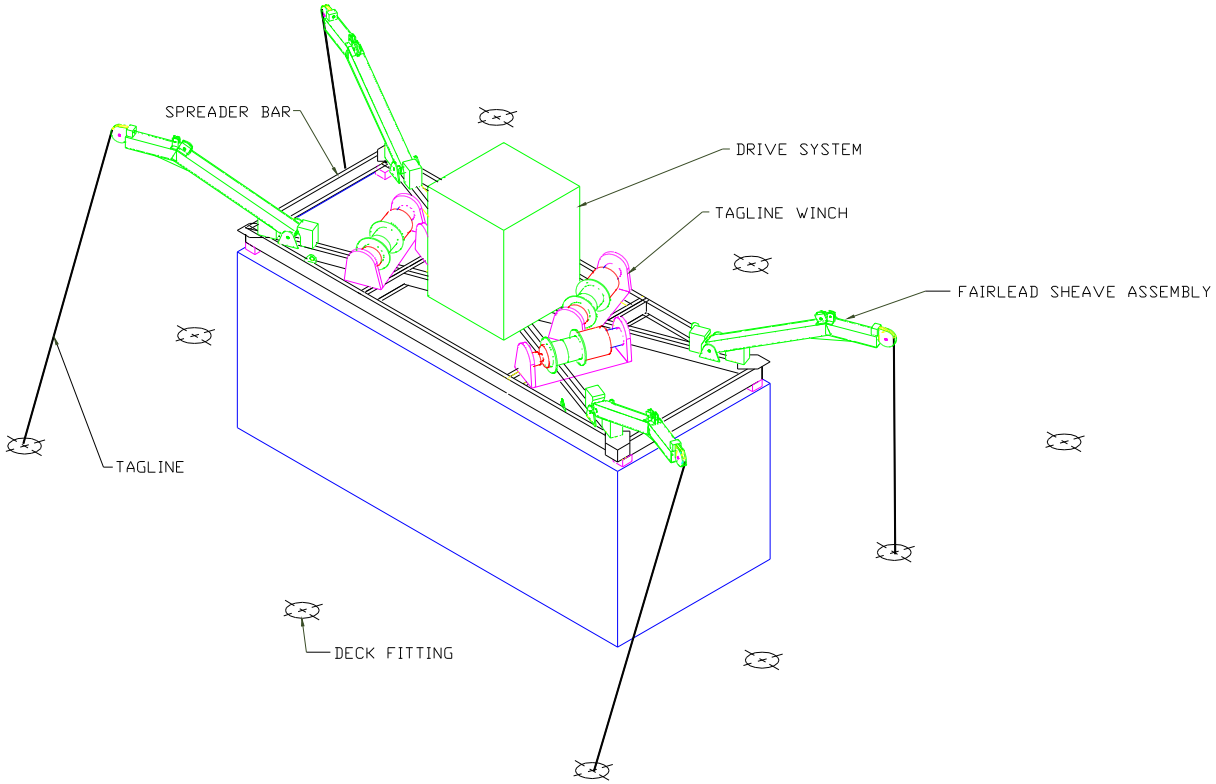
Normal Working Zone for Lift and Taglines

PLATFORM MOTION COMPENSATION (



Develop a system to compensate for the vertical motion
of a load caused by own ship motion.
Investigate relative motion between the ship and a lighter.

Spreader Bar Tagline System



Reduce pendulation and provide positive control of containers during sea state 3 transfer from the T-ACS ship to alongside lighters via powered taglines.

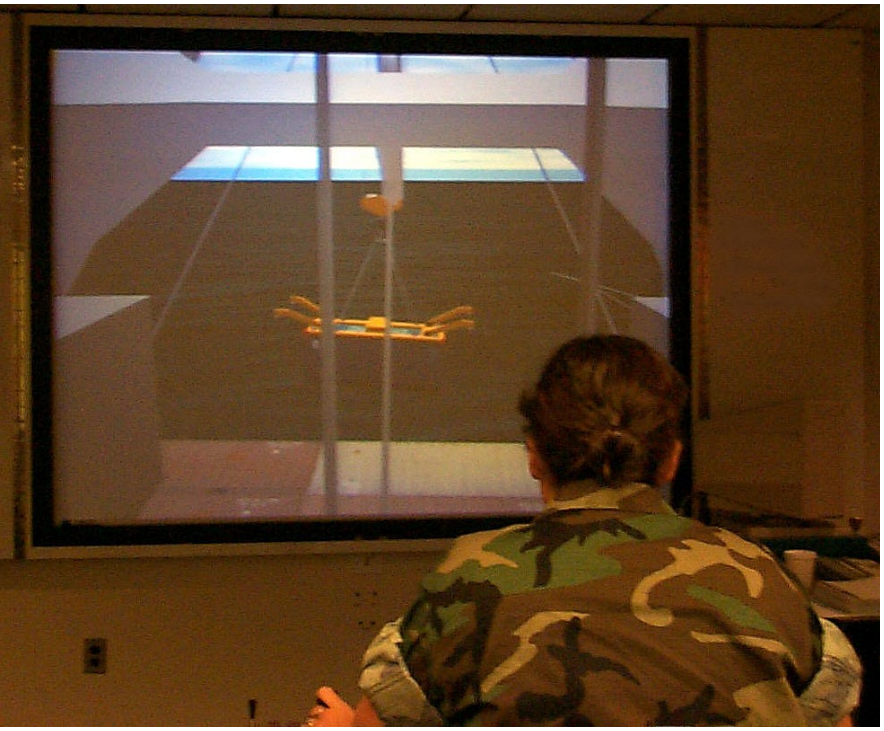
Spreader Bar Tagline System

Reduce pendulation and provide positive control of containers during sea state 3 transfer from the T-ACS ship to alongside lighters via powered taglines.

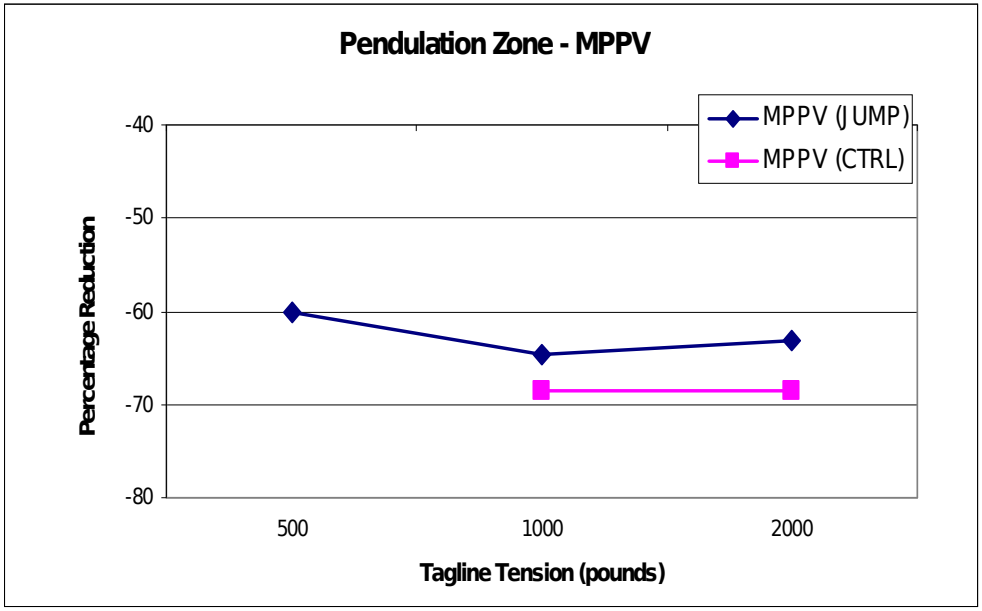
- Dynamic modeling complete
- Operator in the loop simulations - FY99

Spreader Bar Tagline System

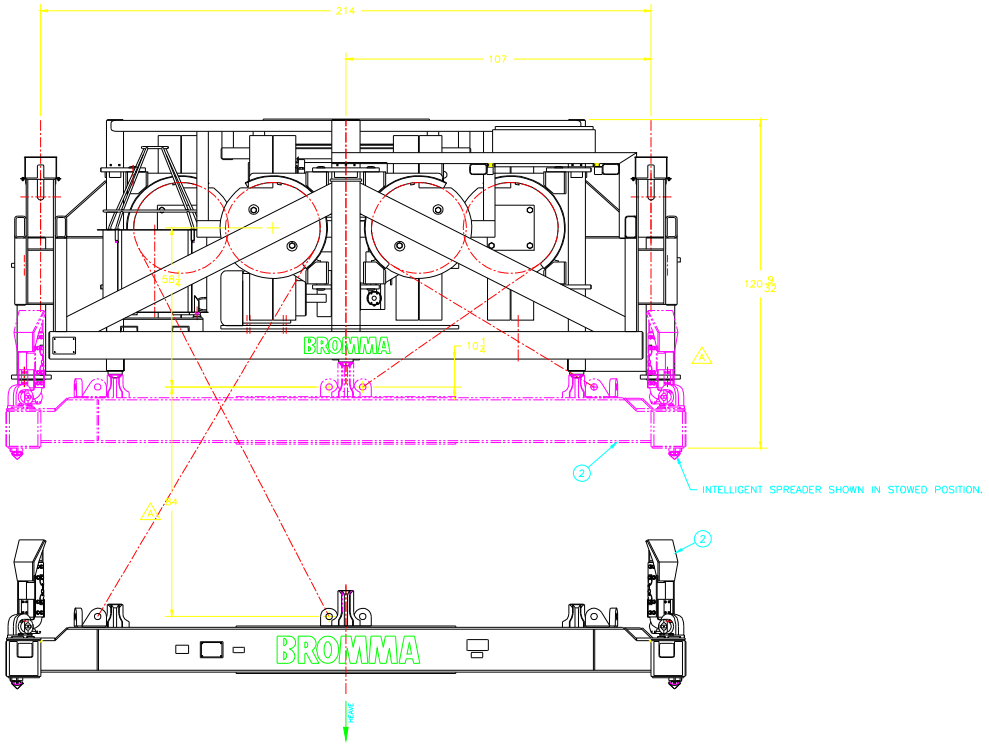
“Man-In-The-Loop” Simulation



Pendulation Zone Reductio



Intelligent Spreader Bar System



6 Degree-of-freedom spreader bar system for rapid connection to and placement of containers in sea state 3.

Intelligent Spreader Bar System

Fabricate and test telerobotic version of the ISB.

Fabrication - Ongoing

Factory Testing - Complete November ‘99

Installation/Field Test at MOTSU - Complete December ‘99

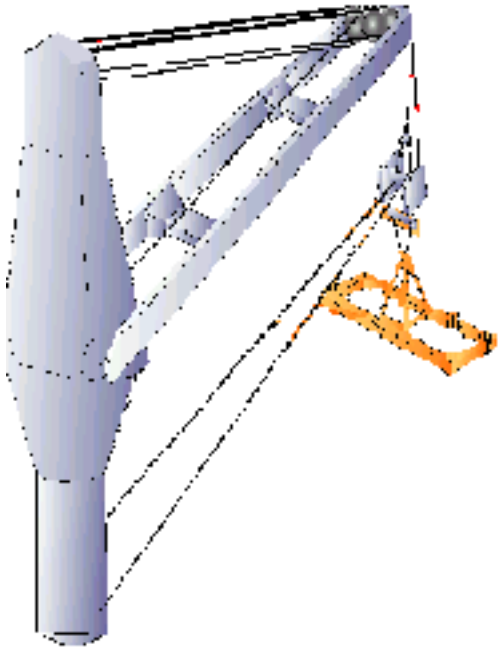
Recommendations for Automation - January ‘00

Future: Perform computer simulations using motion data from MOTSU field test. Expand work on machine vision sensor system required for automatic control of the ISB. Investigation of pedestal crane version of ISB.

Stereovision for Crane Operation

Employ camera systems to assist the crane ope

- Increase productivity
- Increase Safety
- Reduce damage to cargo and equipment
- Aid in operations in rough weather
- Ease operator fatigue and stress



Camera Locations:

- Boom-Tip
- Mid-Boom
- Rail (view of lighter or pier)

Stereovision System:

Dual cameras send real-time video to stereo-capable displays.
A variety of display methods exist
Lightweight, partial immersion head mounted display (HMD) sele

Stereovision System

Stereo camera pairs feed head mounted display to provide crane operator with choice of multiple viewpoints and/or close-up of work area.

Stereovision for Crane Operation

- **Installation on Flickertail State - Apr 00**
- **Functional System Testing**
- **Crane Operator Training**
- **Operational Testing**

Lightweight Rigging

Objective Provide durable, cost effective lightweight rigging system for JLOTS crane lifts.

Accomplishments Researched literature, selected materials (synthetic slings and steel sling shackles) Purchased test materials

Tested lightweight slings during NAVCHAPGRU MPF download / upload operations at Blount Island Command

FY00 Evaluate data and lessons learned, work with NAVCHAPGRU to incorporate as standard purchase

ONGOING EFFORTS

- Advanced Shipboard Crane Motion Control System ATD
- Improved Rider Block Tagline System
- Platform Motion Compensation System
- Stereovision system
- Spreader bar tagline system
- Intelligent Spreader Bar
- Lightweight Rigging